

China's Solar Future

A Recommended China PV Policy Roadmap 2.0

April 2011



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INTRODUCTION

In 2009, SEMI PV Group and SEMI China PV Advisory Committee released a white paper entitled China's Solar Future – A Preliminary Report on a Recommended China PV Policy Roadmap, petitioning for government support in expanding the industry and opening up a domestic market for PV. The Roadmap attempted to present an overview of China's energy profile, growing need for energy, the benefits of PV, and global status of PV. The Roadmap also attempted to provide an in-depth analysis of the cost of crystalline silicon based PV systems and the cost of PV electricity. It delineated a PV installation roadmap with clear annual targets up to year 2020. The Roadmap also looked at different government incentive models, provided projected government spending levels for each model and offered a number of policy recommendations.

Much has happened in the global PV industry since the Roadmap was first introduced in 2009. SEMI PV Group and SEMI China PV Advisory Committee, together with China PV Industry Alliance (CPIA), are pleased to present a new Recommended China PV Policy Roadmap. The new recommended Roadmap is based on analysis of updated information on China's energy objectives and electricity consumption forecast, and uses International Energy Agency (IEA) Solar PV Roadmap global PV penetration forecast as an important benchmark.

SEMI PV Group, SEMI China PV Advisory Committee, and CPIA recommend that, using IEA Solar PV Roadmap as a benchmark, China reach global average PV electricity penetration level with 1.3% PV electricity by 2020, and 4.6% PV electricity by 2030. In order for China to reach these levels of PV penetration, China will need to have 60GW installed PV capacity by year 2020 and 270GW by year 2030. China's current PV power consumption is less than 1GW - well below Japan, USA and many European countries - requiring a dramatic increase in government support to achieve these goals.

IEA World Energy Outlook

The world's growing energy needs have presented two critical challenges to every nation – climate change and energy security. Governments around the globe have been taking actions to tackle these challenges. The IEA New Policies Scenario as presented in its World Energy Outlook 2010 predicts global energy demand will continue to grow, and the share of fossil fuels will decline, from 81% in 2008 to 74% in 2035. This prediction is based on broad policy commitments that have been announced by nations around the world, and these public policies will shape the future of world energy in the long run.

China's Clean Energy Commitment

China's government also publicly announced its commitment under the Copenhagen Accord and pledged to the world that it will reduce its carbon intensity (CO₂ emission per unit of GDP) by 40-45% from the 2005 level, and to increase the share of non-fossil fuels in the primary energy use to 15% by year 2020.

China Plays Critical Role in Global Energy Market

Currently, China is among the world's top energy consumers and largest emitters of greenhouse gases. Both factors contribute to the growing importance of China in global energy markets. IEA predicts that given China's low per capita energy usage and continued economic expansion, the growth prospects of China's energy demand remain very strong.



	Total Primary Energy Demand (Mtoe)							CAGR (%)
	1990	2008	2015	2020	2025	2030	2035	2008-2035
World Total	8,779	12,271	13,776	14,556	15,263	16,014	16,748	1.2%
China	872	2,131	2,887	3,159	3,369	3,568	3,737	2.1%
China as % of World Total	10%	17%	21%	22%	22%	22%	22%	

Figure 1 – Total Primary Energy Demand and CAGR

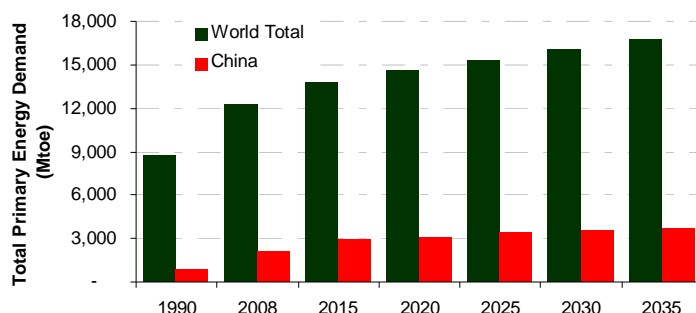


Figure 2 - Source: IEA World Energy Outlook 2010, SEMI

China's government has long realized that development and deployment of clean energy technologies will play a central role in helping China meet the energy and climate challenges, and at the same time sustain its massive economic growth. In the past several decades, the government has taken notable steps in policy making to promote the development of non-fossil energy sources. The energy demand in China today would be even higher had the country not made remarkable progress in reducing its energy intensity (the energy input required per dollar of output). In 2009, China consumed about one-quarter of the energy per unit of economic output than it did in 1980 (IEA). China has also become the world leader in clean tech investment. According to a senior official from the Ministry of Science and Technology, China invested 30 billion U.S. dollars in clean technology in 2009, more than any other nation, and the market size of China's clean tech sector is expected to reach up to more than 100 billion U.S. dollars in 2020 (People's Daily Online, 12/29/2010).

Electricity Demand and Supply

The electricity sector is a key component of global total energy consumption. IEA predicts electricity's share of global total energy consumption will grow to 23% in 2035 from 17% in 2008, and the world total electricity demand in the IEA New Policies Scenario is projected to grow by 2.2% per year between 2008 and 2035. China will grow at a much faster pace at a CAGR of 3.8% during the same period. In absolute terms, China will see the biggest increase in electricity generation capacities among all nations.

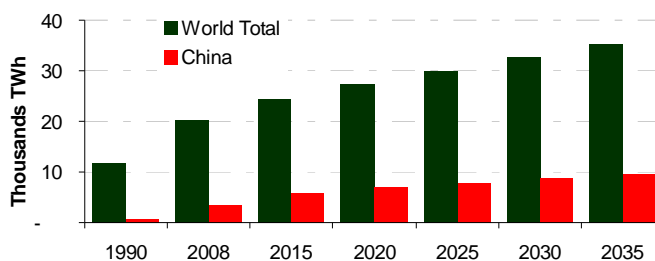


Figure 3 – IEA New Policies Scenario

	Total Electricity Demand (TWh)							CAGR (%)
	1990	2008	2015	2020	2025	2030	2035	2008-2035
World Total	11,821	20,183	24,513	27,373	30,016	32,696	35,336	2.1%
China	650	3,495	5,721	6,949	7,900	8,776	9,594	3.8%
China as % of World Total	5%	17%	23%	25%	26%	27%	27%	

Figure 4 - Source: IEA World Energy Outlook 2010, SEMI

To meet the increasing electricity demand and combat the challenges of climate change and energy security, the global electricity generation will continue to undergo a significant transition toward low-carbon technologies to achieve diverse mix. Coal still plays the central role in China's electricity generation, representing about 73% of the country's total generation capacity. Coal represented about 62% of newly installed capacity in 2010, demonstrating that China is still highly dependent on this energy source, but also moving toward alternative energy sources.

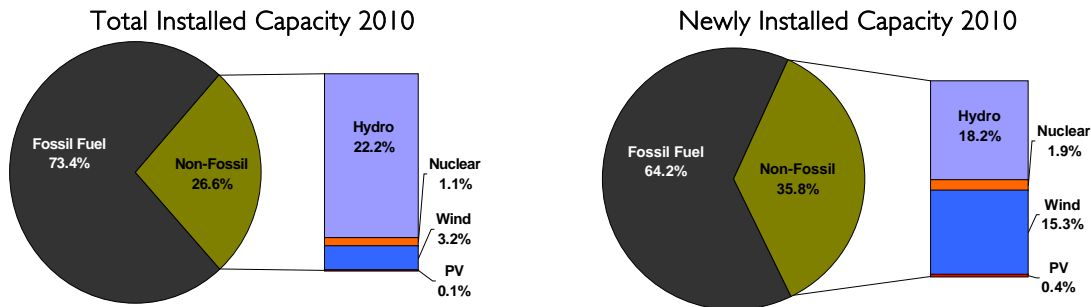


Figure 5 - Source: China Energy Administration, SEMI

The Proposed China New Energy Stimulus Plan

The capacity additions required to meet China's electricity needs are staggering. According to the proposed new energy stimulus plan, China will need to add nearly 700GW new generation capacities in the next 10 years to meet its projected electricity demand. The proposed plan laid out a green roadmap for China with aggressive targets for clean energy. Under the proposed plan, China plans to increase its installed capacity of hydro power, nuclear power, and wind power to 300GW, 75GW, and 120GW respectively by year 2020. The goal of solar power generation under the plan is much more conservative compared to that of other sources, reaching only 20GW by year 2020. (Source: NDRC)

It has been more than a year since the energy stimulus plan was first proposed. Many experts question whether the ambitious goals for hydro, nuclear, and wind are realistic. Many speculate that this could be the reason why the government of China still has not made a final plan.

The increase in hydro capacity in the proposed plan would be equivalent to six Three Gorges dams. What's more, China's rich hydro resources are concentrated in the remote southwestern regions. Besides mitigating potential massive social and environmental impacts, China also needs to resolve the challenge of long-distance transmission to be able to utilize these hydro resources. Though China currently only has 13 operating nuclear plants, it has the most aggressive plan among all nations to add nuclear capacities in the coming decade. In the wake of Japan's troubled nuclear plants, China needs to seriously reevaluate whether nuclear is a viable energy solution for China in the long run. China has rich wind resource and its wind generation capacity has experienced phenomenal growth in the past decade, reaching 30GW by the end of 2010. However, almost all wind generated power needs to be fed into the grid, and many wind projects are still struggling with grid connection issues, and as a result, a significant portion of wind capacity is left idle. Continued rapid expansion of wind is difficult before the grid connection bottleneck is resolved.

The Competitive Advantages of PV

All renewable energy sources are key to China's green roadmap, but solar PV offers unique benefits and opportunities. Solar energy is by far the largest energy resource available on earth and offers distinctive benefits no other renewable resources can.

- PV systems can be developed anywhere on suitable land and on buildings.
- PV systems are modular, offering the flexibility to scale up and down.
- PV systems can be installed close to demand centers and their peak production coincides with peak electricity demand.
- Decentralized generations do not require major transmission investment.
- What's more, the price of PV has declined significantly, and the potential for further cost reduction is very promising. Some experts believe that as conventional fuel prices rise and PV prices fall, generation costs of PV may reach parity with some fossil energy sources in as little as a few years.

China has abundant solar energy resources and the world's largest rooftop areas, which offer tremendous opportunity for PV installations. PV should be an important part of the energy mix for China to meet its emission reduction and renewable energy goals.



CHINA PV INDUSTRY OVERVIEW

Fast Ramping with Significant Capacity Expansion of the Entire PV Supply Chain

Benefited from the strong demand in the European PV market, China PV industry has experienced a rapid development since 2004. In fact, the annual growth rate consistently exceeded 100 percent for the past 5 years. Since 2007, China has become the biggest solar cell maker in the world. In 2010, the number of solar cells manufactured in China exceeded 50% of global output. Up to now, tens of PV companies were listed on the stock markets in China and overseas. The revenue of the entire China PV industry already exceeds RMB300 billion, and the workforce scale reached 300,000.

China's PV industry has moved into the fast ramping phase. Many key technologies in cell manufacturing, silicon purification have been fully adopted by local companies. The key equipment and raw materials are localized. With manufacturing capacity rapidly expanded, full supply chain developed, cost reductions achieved - all this progress has built up China's competitiveness.

	2010 Capacity	2010 Output
Polysilicon	85,000 Tons	45,000 Tons
Silicon Ingot/Chip	23GW	11GW
Si Solar Cell	21GW	8.5GW
Thin film Cell	2.5GW	0.5GW

Figure 6 – 2010 Capacity vs. Output

The Growing Trend of PV Industry in China

From 1978 to 2010, the price of solar cell modules dropped from 78 USD to less than 2 USD. The price decline of raw materials, conversion efficiency improvements, and large scale adoption worldwide are all factors that have together pushed down solar cell prices.

As a traditional low cost region, with major equipment and raw material localization, China PV industry development will become a new major contributor to enable fast cost reduction of PV systems and speed up PV adoption and installations around the world. Moving forward, 'Made in China' will not just mean low-cost and high-quality, but will also indicate continuous improvement and innovation.

The China PV industry faces both challenges and opportunities. Manufacturing capacity expands rapidly in the entire supply chain, and the trend of vertical integration in the supply chain is emerging. Take the crystalline cell industry as an example, companies such as Suntech, Jaso, Yingli and Trina do not only expand cell production capacity aggressively, but also extend their business scope into up/down-stream activities, including polysilicon manufacturing, silicon casting and saw, PV module manufacturing and PV system installation.

The capacity mismatch in the domestic supply chain will not be resolved in short term. It is the result of constraints/barriers in technology, policy, capital investment and other areas. Using polysilicon supply as an example, in 2010 China solar cell makers only can get 50% of their polysilicon supply from local sources, and the rest relies on imports. This leads to competition in polysilicon sourcing and keeps the price of polysilicon high. According to the statistics from China customs, the imported amounts of polysilicon reached 22,727 tons and 47,549 tons in 2009 and 2010 respectively.

There is more and more competition domestically and internationally, while the technology and product innovations keep rolling out. Outside of the PV industry, big investors and traditional electronics manufacturing giants worldwide keep an eye on PV and start to take active steps to enter the PV business. They may change the PV industry landscape and create more uncertainty in the industry. Inside the PV industry, the leading enterprises focus on technology and product development, which will become the key

differentiator in the competition. Many local equipment makers and the raw material suppliers are also taking action to enhance R&D. It is expected that the enforcement of R&D and the breakthrough in key technologies will change the development and competition patterns of China's PV industry.

Seven Trends in the China PV Industry

1. The breakthrough of thin film solar cell technology enables the market share expansion of thin film solar cell;
2. The backend markets of PV system installations and parts show large growth potential domestically and internationally;
3. The PV manufacturing equipment industry is moving to China and there is a large opportunity for this sector to grow in China;
4. Raw material and equipment manufacturing, which is the constraint of the whole supply chain expansion, will become a hotpot of investment;
5. Financial flexibility and other non-technical offers/features may become a dominating factor in competition;
6. The new players with scale or other competitive advantages will change the current pattern of PV markets;
7. The breakthrough in technology also will change the industry landscape.

DEVELOPMENT OF CHINA'S PV MARKET AND GOVERNMENT INCENTIVE PROGRAMS

Driven by increasing global demand, Chinese companies have been rapidly ramping up production capacities, making China the world's top producer of PV cells and modules. In 2010, China produced more than 50% of global total production of solar cells and modules.

However, on the PV installation front, the situation is quite different. Historically, the high cost of PV electricity has restricted its market growth in China. For many years, China only focused on off-grid rural electrification projects, which only allowed for a very small amount of installations.

The cost of PV has declined sharply since 2009, and the past two years have seen some important developments in China's policies for domestic PV market. In March 2009, the Ministry of Finance, together with the Ministry of Urban and Rural Development introduced a national PV subsidy program to promote the use of BIPV applications and rooftop systems. The BIPV and rooftop subsidy program was the turning point of China's PV market. A few months after its launch, in July 2009, the Ministry of Finance, together with the Ministry of Science and Technology, and the National Energy Administration of the National Development and Reform Commission unveiled the second national PV subsidy program, the Golden Sun Demonstration Program, which was designed to subsidize 600MW of PV demonstration projects in the following two to three years.

Moreover, in 2009, China central government introduced an FIT style subsidy for a 10MW Dunhuang project where the tariff was determined through open bidding and additional 280MW projects were offered for bidding in 2010.

All these government incentive programs have led to a wave of enthusiasm for PV across the country, and created a surge in China's PV market. In 2009, China's new PV installations reached 160MW, a fourfold increase from 2008 level, and another 400-500MW was installed in 2010. Many analysts believe China will increase its PV installations to 1GW in 2011, double the amount of 2010.

Annual PV Installation (MW)

	2006	2007	2008	2009	2010 (E)
World Total	1,603	2,932	5,950	7,380	16,000
China	10	20	40	160	400
China as % of World Total	0.6%	0.7%	0.7%	2.2%	2.5%

Source: China NDRC, SEMI

Figure 7 – Annual PV Installations

Even with these impressive growth rates in recent years, China's share of PV installations is quite small compared to global total installations. In 2010, China represented just over 2% of the global total PV market.

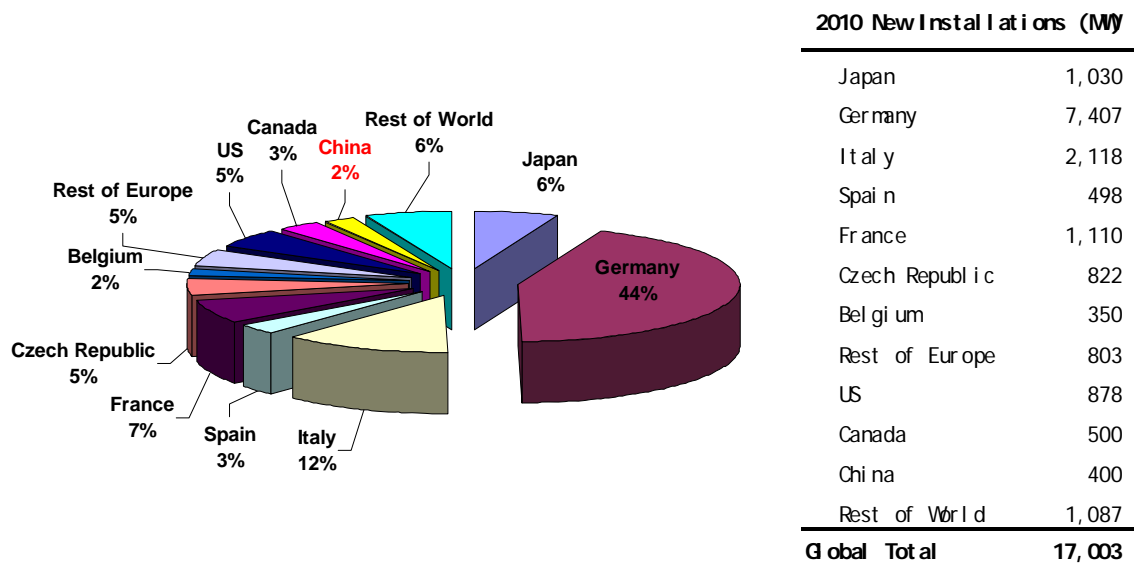


Figure 8 - Source: Barclays Capital Research, GSE, SEIA, and SEMI

China's PV incentive programs contributed to the rapid growth of China's PV market in the past couple years. However, the burgeoning PV market is still considered as an experimental phase by China government, and projects are still for demonstration purposes. Some issues have arisen, indicating underlying deficiency and lack of coordination of these supporting programs, in some cases even acted against the goal of stimulating the development of domestic PV market.

For instance, oftentimes PV system operators find it difficult to keep projects afloat due to insufficient subsidy and low margins. In order to win the bidding war for PV projects, many companies submitted bids regardless of project economics, resulting in FIT rates that are unprofitable for project operators. FIT rates that are inconsistent with PV cost structure impose a negative impact on the market.

The incentive programs that subsidize capital cost of PV systems, such as Golden Sun Demonstration Programs, have also encountered many challenges. Some companies, including industry leaders, withdrew projects from the Golden Sun program even after their projects were approved by the government, simply because these projects would lose money if they continued, due to insufficient subsidy. There have also been incidents where companies use inferior products for projects in response to inadequate subsidies. Another drawback in China's PV incentive programs is that there has been difficulty in implementing these policies and accurately measuring successes or failures.

Compared with China's history of investment in wind power, China government has taken a more conservative approach for PV. As China learns important lessons from these programs, the industry hopes that the implementations of these policies have laid a solid ground for the adoption of new measures in the coming years.

The Recommended China PV Policy Roadmap (2009)

In the first SEMI white paper on China PV market entitled China's Solar Future – A Preliminary Report on a Recommended China PV Policy Roadmap, SEMI PV Group and SEMI China PV Advisory Committee urged China government to expedite the development of a domestic PV market in China and recommended a PV installation roadmap with annual installation targets to year 2020, reaching global average PV penetration level by year 2016, and 1.3% electricity from PV by year 2020.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity Demand (Billion kWh)	2,652	2,783	2,914	3,052	3,196	3,346	3,504	3,643	3,787	3,938	4,094	4,256
% of PV Electricity (Global Average)	0.16%	0.20%	0.24%	0.29%	0.35%	0.42%	0.51%	0.61%	0.74%	0.89%	1.08%	1.30%
Cumulative Installation Needed to Achieve Global Average Level (MW)	2,632	3,479	4,393	5,547	6,226	7,861	9,926	12,444	15,600	19,558	24,518	30,738
China's Current National Target (MW)		300										1,800
Proposed Cumulative Installation (MW)	340	840	1,650	2,800	4,300	6,180	8,840	12,280	15,780	19,510	24,485	30,785

Figure 9 - A Recommended China PV Policy Roadmap (2009)

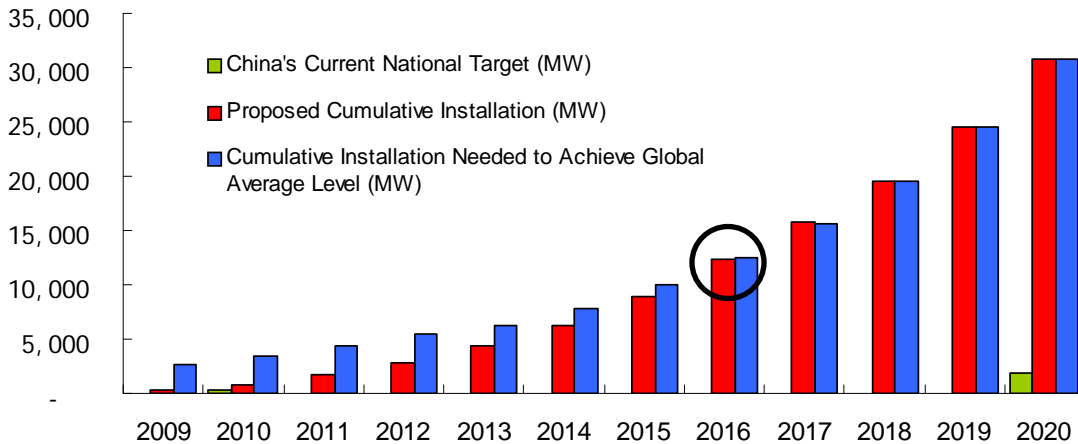


Figure 10 - Source: SEMI

NEW RECOMMENDED CHINA PV POLICY ROADMAP

In the Solar PV Roadmap published by IEA in May 2010, IEA states that PV power is a commercially available and reliable technology with a significant potential for long-term growth in nearly all world regions. The roadmap estimates that by 2020, PV will provide around 1.3% global electricity production and will go up to 11% by 2050.

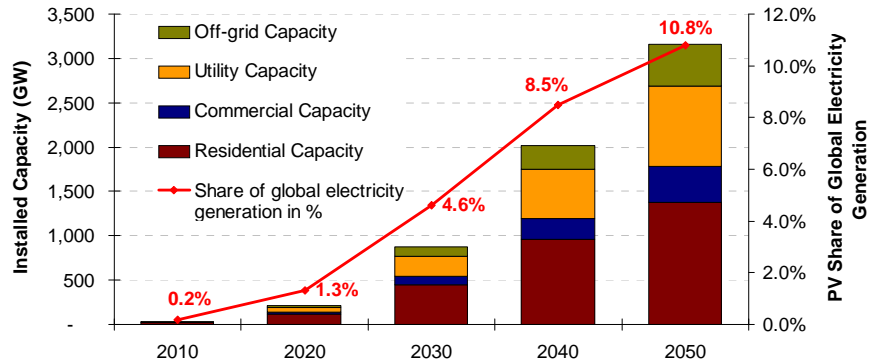


Figure 11 - Source: IEA Solar PV Roadmap, SEMI

SEMI PV Group, SEMI China PV Advisory Committee, and CPIA recommend that, using IEA Solar PV Roadmap as a benchmark, China reach global average PV electricity penetration level with 1.3% PV electricity by 2020, and 4.6% PV electricity by 2030. In order for China to reach these levels of PV penetration, China will need to have 60GW installed PV capacity by year 2020 and 270GW by year 2030. The goals presented in the recommended policy roadmap are challenging; however, these goals are attainable with strong government commitments and the right policies in place.

	2010 Actual	2010	2020	2030
Total Electricity Generation (TWh)	4,192	4,192	6,949	8,776
% of PV Electricity	0.025%	0.2%	1.3%	4.6%
Electricity Generation from PV (TWh)	1	8	90	404
Total Installed PV Capacity (GW)	0.7	6	60	270

Figure 12 - Recommended China PV Policy Roadmap

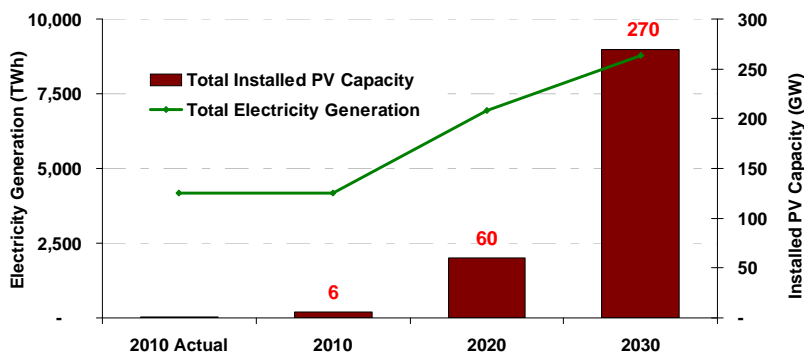


Figure 13 - Total Electricity Generation based on IEA World Energy Outlook 2010 New Policies Scenario. PV electricity generation assumption – 1.5 kWh/kWp per year (Source: SEMI)

POLICY RECOMMENDATIONS

- **It is recommended that China reevaluate the untapped potential of PV electricity generation, set specific targets for PV, and expedite the growth of China's domestic PV market.**

It is hoped that the goals presented in the recommended policy roadmap will serve as a reference document for Chinese government when setting national targets and new policies for PV. The exact outcome is still unclear, but what's certain is that relying only on hydro, wind, and nuclear will not be sufficient for China to address the challenges of climate change and energy security. PV must be an important part of the solution.

What's more, China's PV industry has become the largest in the world and it has become an important economic contributor for many regions in China. Currently China's internal market is insignificant and unattractive to Chinese PV makers. Countries such as Germany and Italy have seen record levels of solar demand driven by a combination of attractive subsidy support and rising supply of low-cost PV products from China. However, the situation may start to change as European countries continue to adjust their incentive levels to control the demand. The global political support for PV will continue to be strong, but Chinese PV companies will have to look to domestic market as a critical outlet for their products.

- **It is recommended that China adopt new measures to support the deployment of PV.**

New measures should incorporate more market mechanism, with clear implementation details and evaluation procedures. China can learn from international best practices and develop a government support system that best fits China's unique situations.

The Feed-in Tariff (FIT) subsidy system has been instrumental in driving global PV demand, especially in Europe. More than 40 countries have introduced FIT for renewable energy. Though China government is undecided on a national FIT scheme, it deserves serious consideration from the policy makers. Another successful practice is the Renewable Portfolio Standard (RPS). RPS, especially those with a solar carve-out, have been instrumental in driving PV markets, especially in the U.S. China should also look into similar incentive scheme. For instance, a mandatory quota may be imposed on renewable energy power generation, with specific quota for PV. The quota could be applied to the grid operators, requiring them to purchase a certain percentage of PV power, or applied directly to power companies, requiring them to generate certain percentage of power from PV.

Incentives, whether in the form of an FIT or capital investment subsidy, should be determined based on PV's cost structure and market conditions to ensure sustainable market growth.

- **It is recommended that China look into its vast building space and promote rooftop and BIPV deployment.**

Distributed generation and local consumption are unique benefits of PV. In order to grow this market segment, not only China needs to have the right policy in place, but also need to improve its sophistication in grid interconnection.

- **It is recommended that China cultivate a more diverse PV market to ensure a healthy and efficient market.**

It appears that state-run companies, mostly China's utility groups and power grid operators, have dominated the winning bids for PV projects, and privately-run businesses have little chance to win simply because they can not afford the cut-throat competition. In order for the healthy growth of PV market, China needs to cultivate a more diverse market that is attractive to state-run, private, and international players.

WHAT'S NEXT

Historically, China government has played a central role in China's energy sector, and it will continue to do so. The future of renewable energy, including PV, hinges critically on strong government support. While dealing with many controversial issues and international pressures, China could lead the world into a new age for energy. Many analysts believe China will be the next major growth market for PV. This offers tremendous opportunity for the global clean tech industry. SEMI PV Group, SEMI China PV Advisory Committee, and CPIA will continue its industry advocacy effort, bringing together the global industry and the government on the path of a clean and secure energy future.

ABOUT THE AUTHORS

This white paper was prepared by SEMI PV Group, SEMI China PV Advisory Committee, and China PV Industry Alliance (CPIA).

SEMI and PV Group

SEMI is the global industry association serving the manufacturing supply chains for the microelectronic, display and photovoltaic industries. SEMI member companies are the engine of the future, enabling smarter, faster and more economical products that improve our lives. Since 1970, SEMI has been committed to helping members grow more profitably, create new markets and meet common industry challenges. SEMI maintains offices in Beijing, Bengaluru, Berlin, Brussels, Grenoble, Hsinchu, Moscow, San Jose, Seoul, Shanghai, Singapore, Tokyo, and Washington, D.C. For more information, visit www.semi.org.

PV Group represents SEMI member companies involved in the solar energy manufacturing supply chain. Members provide manufacturing equipment, materials, cells, modules, sub-systems, and components to the solar energy industry worldwide. Our mission is to advance industry growth, support continuous efficiency improvements and promote sustainable business practices through international standards development, events, public policy advocacy, EHS support, market intelligence, and other services. www.pvgroup.org



China Photovoltaic Industry Alliance (CPIA)

China Photovoltaic Industry Association (referred as CPIA) founded in May 17, 2010, was under the leadership of Ministry of Information and Industry Technology (MIIT) and National Development and Reform Commission (NDRC), its headquarters is located in Beijing, China. China Photovoltaic Industry Alliance (CPIA) is actively devoted to solar PV industry, and is a non-profit social organization comprised of enterprises and public institutions with volunteers in the filed of R&D, manufacturing and services of solar PV products and application. CPIA is initiated by 22 industrial elites, covering the entire solar PV industrial chain from polysilicon (poly-Si), solar cell and application system to professional equipment, with industrial research institutions and trade association included as well. These 22 leading alliance member companies cover >70% of the poly-si production in China and >50% of cell modules. These enterprises represent a mainstay force of Chinese solar PV industry. www.chinapv.org.cn/

